

THE INVENTION CLAIMED IS:

1. A method for synthesizing an arbitrary waveform that approximates a specific waveform, the method comprising:

specifying respective frequencies of component waveforms to be used to generate the arbitrary waveform, the frequencies being less than the maximum frequency needed to synthesize the specific waveform;

performing a least squares optimization of respective amplitudes and phases of the component waveforms across at least one predetermined time interval; and

summing the component waveforms having the amplitudes and phases optimized by the least squares optimization to produce the arbitrary waveform.

2. The method of claim 1 further comprising performing the least squares optimization by integrating across the specified time interval the square of the difference between the specific waveform and the sum of the respective component waveforms as a function of time, and solving for a minimum value.

3. The method of claim 1 wherein the component waveforms are harmonically related.

4. The method of claim 1 further comprising omitting at least one of the component waveforms when its respective optimum amplitude is less than a predetermined value.

5. The method of claim 1 further comprising phase-modulating an input signal in response to at least a portion of the arbitrary waveform to perform frequency conversion on the input signal.

6. A method for synthesizing a waveform $g(t)$ that approximates a waveform $n(t)$, the method comprising:

specifying respective frequencies f_1, \dots, f_{\max} of component waveforms to be used to generate the waveform $g(t)$, the frequencies f_1, \dots, f_{\max} being less than the maximum frequency needed to synthesize the waveform $n(t)$;

performing a least squares optimization of respective amplitudes and phases of the component waveforms across at least one predetermined time interval using the equations:

$$\frac{\partial \xi}{\partial a_j} = \frac{\partial}{\partial a_j} \int_{t_0}^{t_1} [n(t) - g(t)]^2 dt$$

$$\frac{\partial \xi}{\partial b_j} = \frac{\partial}{\partial b_j} \int_{t_0}^{t_1} [n(t) - g(t)]^2 dt$$

; and

superimposing the component waveforms having the amplitudes and phases optimized by the least squares optimization to produce the waveform $g(t)$.

7. The method of claim 6 further comprising performing the least squares optimization by integrating across the specified time interval the square of the difference between the waveform $n(t)$ and the sum of the respective component waveforms as a function of t , and solving for a minimum value.

8. The method of claim 6 wherein the component waveforms are harmonically related.

9. The method of claim 6 further comprising omitting at least one of the component waveforms when its respective optimum amplitude is less than a predetermined value.

10. The method of claim 6 further comprising phase-modulating an input signal in response to at least a portion of the waveform $g(t)$ to perform frequency conversion on the input signal with the frequency of the frequency converted signal being represented by the equation $V_0 = A \times \sin((\omega_0 + \omega_m)t + \phi_0)$.

11. Apparatus for synthesizing an arbitrary waveform that approximates a specific waveform, the apparatus comprising:

circuitry for specifying respective frequencies of component waveforms to be used to generate the arbitrary waveform, the frequencies being less than the maximum frequency needed to synthesize the specific waveform;

circuitry for performing a least squares optimization of respective amplitudes and phases of the component waveforms across at least one predetermined time interval; and

circuitry for summing the component waveforms having the amplitudes and phases optimized by the least squares optimization to produce the arbitrary waveform.

12. The apparatus of claim 11 wherein the least squares optimization is performed by integrating across the specified time interval the square of the difference between the specific waveform and the sum of the respective component waveforms as a function of time, and solving for a minimum value.

13. The apparatus of claim 11 wherein the component waveforms are harmonically related.

14. The apparatus of claim 11 wherein at least one of the component waveforms is omitted when its respective optimum amplitude is less than a predetermined value.

15. The apparatus of claim 11 further comprising circuitry for phase modulating an input signal in response to at least a portion of the arbitrary waveform to perform frequency conversion on the input signal.

16. Apparatus for synthesizing a waveform $g(t)$ that approximates a waveform $n(t)$, the apparatus comprising:

circuitry for specifying respective frequencies f_1, \dots, f_{\max} of component waveforms

to be used to generate the waveform $g(t)$, the frequencies f_1, \dots, f_{\max} being less than the maximum frequency needed to synthesize the waveform $n(t)$;

circuitry for performing a least squares optimization of respective amplitudes and phases of the component waveforms across at least one predetermined time interval using the equations:

$$\frac{\partial \xi}{\partial a_j} = \frac{\partial}{\partial a_j} \int_{t_0}^{t_1} [n(t) - g(t)]^2 dt$$

$$\frac{\partial \xi}{\partial b_j} = \frac{\partial}{\partial b_j} \int_{t_0}^{t_1} [n(t) - g(t)]^2 dt$$

; and

circuitry for superimposing the component waveforms having the amplitudes and phases optimized by the least squares optimization to produce the waveform $g(t)$.

17. The apparatus of claim 16 wherein the least squares optimization is performed by integrating across the specified time interval the square of the difference between the waveform $n(t)$ and the sum of the respective component waveforms as a function of t , and solving for a minimum value.

18. The apparatus of claim 16 wherein the component waveforms are harmonically related.

19. The apparatus of claim 16 wherein at least one of the component waveforms is omitted when its respective optimum amplitude is less than a predetermined value.

5 20. The apparatus of claim 16 further comprising circuitry for phase-modulating an input signal in response to at least a portion of the waveform $g(t)$ to perform frequency conversion on the input signal with the frequency of the frequency converted signal being represented by the equation $V_0 = A \times \sin ((\omega_0 + \omega_m)t + \phi_0)$.